OCTOBER 2010

Military & Aerospace Electronics

THE MAGAZINE OF TRANSFORMATION IN ELECTRONIC AND OPTICAL TECHNOLOGY

Electronics cooling

Industry innovates to solve growing thermal management challenges. PAGE 22

Chassis and enclosures

Design trends in backplane enclosures revolve around high performance, small size. PAGE 36

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Software-defined radio

Industry looks beyond the DOD's Joint Tactical Radio System to explore the new frontier of cognitive radio. PAGE 12

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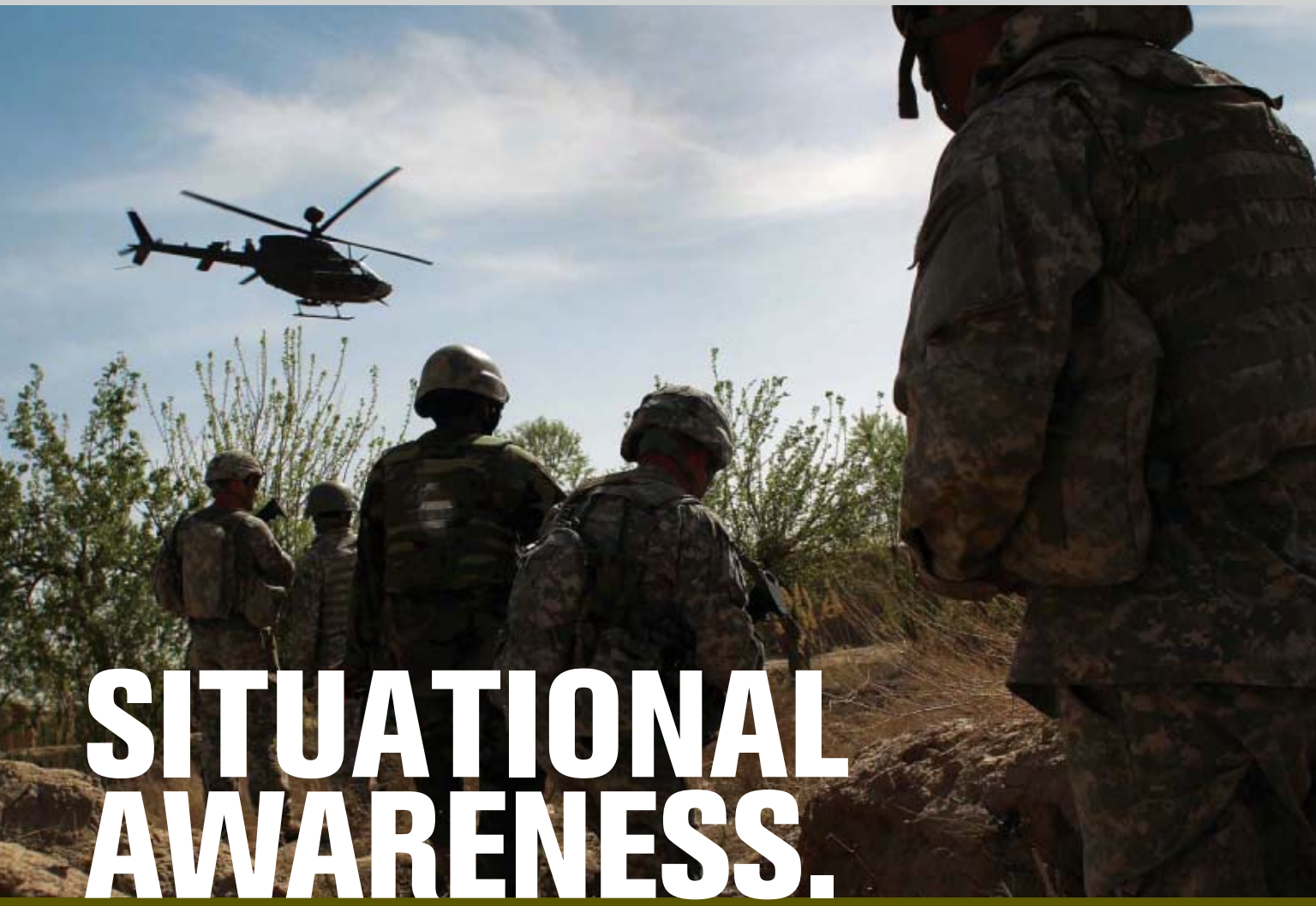

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trends

BY **JOHN KELLER**, EDITOR IN CHIEF

The information you need, fast and easy

Welcome to the latest redesign of *Military & Aerospace Electronics* magazine, which we launch this month to make it even easier and faster for you to get the latest design, standards, and products information that you need each month. This print magazine redesign comes closely on the heels of a major overhaul of the Military & Aerospace Electronics Web site last spring to help you browse and search the day's latest news that is pertinent to your job.

You may have gotten a hint of new things to come when you first glanced at the cover of this issue—bolder graphics, updated masthead, and quick descriptions of what's inside the issue. In many ways, this latest update completes our transition, begun at the beginning of 2009, from a tabloid publication to standard magazine. Since we made that switch nearly two years ago, we've gotten many compliments from our readers—chiefly because the print issue has gotten more convenient to put in a briefcase to take with you.

We wanted to be careful when we started moving away from our familiar tabloid format toward a standard magazine size because, quite frankly, so much of who we are was wrapped up in our tabloid identify. That old format helped set us apart since we launched the magazine in 1990, and we didn't want to lose that part of our identity.

So, for nearly our first two years as a standard magazine, essentially we transferred our old tabloid masthead over to our standard magazine. You remember it—a blue-and-gray block logo with the characteristic red corner to give readers a taste of what's inside the magazine.

Well, that blue and gray block has run its course. It has disappeared in favor of a modern, up-to-date look, and with it have gone the last vestiges of our tabloid heritage. We still have our unique red corner with content descriptions, but now the corner has switched to the left side to help better draw you into the edition. You'll notice our cover paper stock is a bit heavier, too, to lend the issue more heft and authority.

Take a look inside. You'll see freshened department heads to help you navigate quickly and easily through the news, in-brief, special report, technology focus, product intelligence, opinion, electro-optics watch, product applications, and new products sections. It's all designed for speed and agility—to help you scan for information you need most, and then get back to work.

Everything's moving faster these days—especially our jobs. Every one of us is being asked to do more with less, so we're positioning *Military & Aerospace Electronics* to be part of the solution, not something else to weigh you down.

The improvements are not only limited to our redesigned print magazine; we're making changes online, as well. Take a look by logging on to www.militaryaerospace.com.

We've just included a box at the top called Today's Headlines, which gives you a snapshot of our six most recently posted stories involving breaking news on contracts, standards, and design ins; the latest developments on company news, mergers, and market forecasts in our Defense Executive section, the most recent updates on our Avionics Intelligence sister Web site, and the latest product announcements in our Industry News Flash section.

Just like the improvements to our print magazine, the new changes to our online presence are designed to get you the information you need most, quickly and easily. You also can see our latest postings on Twitter by searching #milaero, or by logging on to the *Military & Aerospace Electronics* page on Facebook at www.facebook.com/pages/Military-Aerospace-Electronics/174732214480.

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news

British Army orders hand-launched persistent-surveillance UAV from Lockheed Martin

BY JOHN KELLER

LONDON—British Army leaders needed hand-launched unmanned aerial vehicles (UAVs) for persistent surveillance in the global war on terror. They found their solution at the Lockheed Martin Corp. MS2 Tactical Systems segment in Eagan, Minn.

The United Kingdom Ministry of Defence (MOD) in London awarded Lockheed Martin a $5.1 million contract for Desert Hawk III hand-launched UAV and control units. Desert Hawk III is designed for portability, quick mission planning, hand launched and skid recovery, multimission versatility, enhanced day/night target detection, recognition, identification, wide operational range, endurance, and covert operations.

The UAV has a gyro-stabilized 360-degree sensor turret, color and low-light electro-optical plug-and-play payloads, and roll-stabilized infrared sensor payloads. Its portable ground station provides operator training, autonomous pre-flight planning, in-flight control of plug-and-play optical and infrared sensors, terrain avoidance measures, and real-time dynamic in-flight mission and flight profile retasking.

Awarded by the MOD Defence Equipment & Support (DE&S) organization, the latest contract calls for Lockheed Martin to deliver the Desert Hawk III UAVs by this fall. "Desert Hawk's latest enhancements allow it to operate more effectively in difficult conditions and provide our soldiers with greater situational awareness in a very timely manner," says Duncan Robbins, program manager for mini-UAV systems at the MOD DE&S.

The Desert Hawk hand-launched UAV from Lockheed Martin will help British Army troops see over the next hill.

"The battle-proven Desert Hawk III can operate in high winds, extended altitude, and extreme temperatures, making it very effective in areas, such as Afghanistan," says Mark Swymeler, a vice president for Lockheed Martin's Ship and Aviation Systems line of business. "Unlike some other UAVs, it is extremely quiet and virtually undetectable beyond 150 meters."

Equipped with steerable, plug-and-play imaging payloads, the Desert Hawk has provided the British Army with situational awareness capabilities in Afghanistan since 2006.

FOR MORE INFORMATION visit **Lockheed Martin** online at *www.lockheedmartin.com.*

IN BRIEF

Embedded vision system from TYZX selected by iRobot military unmanned ground vehicles

iRobot Corp. in Bedford, Mass., chose the DeepSea G3 Embedded Vision System (EVS) from TYZX in Menlo Park, Calif., to provide real-time vision and depth perception for selected new developments in autonomous military robots. The G3 is about the size of a hardback book and processes high-resolution image data at as many as 60 frames per second, while consuming minimal power. For iRobot unmanned ground vehicles (UGVs), the TYZX G3 EVS provides enhanced situational awareness via 3D visualization. Standard monocular cameras provide video footage that is flat, sometimes making it difficult for a robot operator to judge distance. 3D visualization provides depth perception and a more detailed view of the environment, TXYZ officials say. iRobot engineers are developing advanced autonomous navigation algorithms to demonstrate person-following capabilities that will make use of the G3 EVS. TYZX G3 systems also support autonomous obstacle detection and obstacle avoidance (ODOA), which enables robots to navigate through buildings and difficult terrain.

news

Defense researchers eye machine autonomy to enable Navy UUVs to detect and avoid fishing nets and kelp beds

BY JOHN KELLER

NEWPORT, R.I.—The U.S. Navy depends increasingly on unmanned underwater vehicle (UUV) technology for marine reconnaissance, surveillance, target acquisition, and other tasks with the potential to put human lives in danger. One of the biggest obstacles to effective UUV operations, however, involves fishing nets and kelp beds that threaten to entangle UUVs and cause damage or outright loss of these sophisticated underwater craft.

Fishing nets and kelp beds pose critical obstacles to the Navy's unmanned underwater vehicles, so contractors are developing machine intelligence to help these vehicles detect and avoid them, and free themselves, if entangled.

Researchers at the Naval Undersea Warfare Center (NUSC) in Newport, R.I., awarded two contracts in September to give UUVs sufficient machine intelligence and autonomy not only to detect and avoid fishing nets, lines, boats, kelp, and similar obstacles, but also to free themselves should they become entangled.

Fishing nets pose a threat to Navy UUVs, especially in coastal waters and harbors where fishing activity may be extremely heavy. It is in these so-called littoral areas where UUVs tend to be most useful for tasks like persistent surveillance, mine detection and removal, and target acquisition.

In these littoral waters, fishermen use a wide variety of tactics and nets of various sizes and shapes for subsistence and commercial fishing. Nets include gill nets, purse seine nets, trawl nets, lift nets, drift nets, and aquaculture nets made of assorted materials that can cover large areas of the ocean, which creates a physical barrier to UUVs moving through the area, naval researchers say.

NUSC officials awarded a $219,000 research contract to the Charles Stark Draper Laboratory in Cambridge, Mass., and a $262,000 contract to Applied Physical Sciences Corp. (APS) in Groton, Conn., to find new technologies to improve the performance of UUVs in areas around the globe where fishing nets pose a threat.

Draper and APS experts will investigate sensors, and algorithms that enable UUVs to detect and avoid fishing nets, fishing lines, fishing boats, and kelp beds. Their solutions will be scalable for all classes of UUVs, with light- and heavy-weight vehicles of primary interest. Researchers also will investigate technology to enable UUVs to free themselves from fishing nets, lines, or kelp if entangled, as well as net-penetration equipment.

FOR MORE INFORMATION visit the **Naval Undersea Warfare Center Newport** online at www.navsea.navy.mil/nuwc/newport, the **Charles Stark Draper Lab** at www.draper.com, or **Applied Physical Sciences** at www.aphysci.com.

news

Military HF radio communications may prove effective for Internet relay chat in land, sea, and air applications

BY JOHN KELLER

CALIFORNIA, Md.—Military communications experts from Chesapeake Technology International Corp. (CTI) in California, Md., and Rockwell Collins Inc. in Cedar Rapids, Iowa, demonstrated real-time Internet relay chat (IRC) over a high-frequency (HF) radio link using automatic link establishment (ALE) to show the operational viability of providing IRC capabilities to aircraft, land vehicles, fixed-base land sites, surface ships, and submarines using military HF radio communications.

Experts from the two companies established the HF radio communications equipment using two Rockwell Collins VRC-100 HF radio sets between Cedar Rapids, Iowa, and Richardson, Texas—a distance of 700 miles. CTI-provided IRC Proxy software helped link the commercial IRC client and server applications with no modification.

The chat session included Internet participants from across the United States, communicating bi-directionally over the HF link in real time via a standard Internet IRC server connected into the HF radio network by CTI's HF Bridge system.

"This demonstration represents a tremendous leap forward in the operational capability provided by HF communications. It allows all types of platforms to participate in modern Internet communications from remote theaters of operation," says Michael Kepferle, CTI's president and chief executive officer. This capability could enhance operational communications and situational awareness in communications-challenged environments and situations around the world, CTI officials say.

FOR MORE INFORMATION visit **CTI** at www.ctic-inc.com, or **Rockwell Collins** at www.rockwellcollins.com.

news

Northrop Grumman set to build persistent-surveillance airship able to stay aloft for three weeks

BY JOHN McHALE

MELBOURNE, Fla.—Northrop Grumman engineers are creating for the U.S. Army a persistent surveillance unmanned airship able to stay aloft for three weeks—and are producing it in 18 months. Delivery of the Long-Endurance Multi-Int Vehicle (LEMV) is scheduled for December 2012. The contract to the Northrop Grumman Aerospace Systems segment in Melbourne, Fla., was awarded this summer.

Lockheed Martin is developing a high-endurance airship for the U.S. Army able to perform persistent surveillance missions for as long as three weeks.

The LEMV will be untethered and provide persistent intelligence, surveillance, and reconnaissance for up to 21 straight days for an estimated total fuel cost of $15,000—much cheaper than manned or other unmanned aircraft, says Liz DelGrosso, business development representative for Northrop Grumman Aerospace Systems in Melbourne, Fla.

Army specialists are choosing the ISR sensor payloads and providing them to Northrop Grumman for integration. Payload options include radar, full motion video, communication relays, and other components integrated on what Northrop Grumman calls the Murphy Bay on the vehicle bottom centerline. The payloads will be modular, so they are easily swapped in and out, DelGrosso says. The ground control station will be compatible with the Army's universal ground control station. The airship will be a hybrid air vehicle, that can be unmanned or manned, depending on the mission, DelGrosso adds. The LEMV, 300 feet long and 7 stories high, can climb to 20,000 feet.

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SPECIAL REPORT

Reprogrammable radios: FPGAs enable SDR applications

Reconfigurability is a key capability for software-defined radio—especially down at the chip level through field-programmable gate arrays—which offer flexibility and improved power management. Meanwhile, industry researchers are exploring the next evolution in communications—cognitive radio.

BY **John McHale**

Software-defined radios (SDRs), where software controls functionality, are becoming commonplace in military and commercial communications. SDR development was driven initially by the U.S. military's Joint Tactical Radio System (JTRS) program, which seeks to create a system that can reconfigure on the fly to adapt to any radio frequency warfighters need to use. SDR technology is to replace traditional hardware radios that often could not talk to one another.

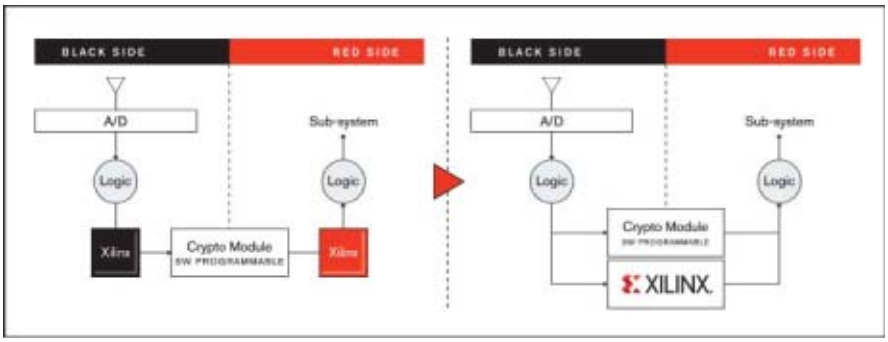
What many may not realize is that the "software" in software-defined radios covers more than traditional software.

Software within an SDR system can be any element that enables the radio to carry out certain tasks. One example is the C code running through a general-purpose processor or a field-programmable gate array (FPGA), says Lee Pucker, chief executive officer for the Wireless Innovation Forum (formerly the SDR Forum) in Phoenix.

FPGAs are natural enablers of SDR applications because FPGAs, like the software-defined radio itself, are flexible and reconfigurable.

Secure SWaP-C: Xilinx Extends Battery Life, Lowers Costs, AND Increases Security for MILCOM

By Colby Hoffman



Xilinx Single-chip Cryptography enables the highest level of information assurance with support for Type-1 systems, while optimizing SWaP-C.

THE NEXT DECADE of Military Communications demands secure communication with an ever-increasing sensitivity to size, weight, power, and cost (SWaP-C) concerns. Battery life will be expected to be days and not just hours, and more functionality must be built into increasingly smaller and less expensive hand-held devices. Xilinx defense-grade FPGA solutions help overcome these challenges, by enabling single-chip designs with improved system security *and* SWaP-C (Secure SWaP-C).

Military communications and other defense applications are not new to Xilinx. For the past 20+ years, Xilinx has advanced cost-effective solutions and design platforms tailored for this industry. The latest Xilinx® Spartan®-6Q FPGA family, for example, features long product lifecycles, high reliability, unique manufacturing flows, specialized design services, and advanced security solutions for high-assurance applications.

Xilinx has earned a clear lead in market share by delivering the highest level of integration of advanced capabilities such as single-chip cryptography (SCC) certifiable to Type-1 requirements, for accelerating development and optimizing Secure SWaP-C. Xilinx pioneered and first introduced the SCC methodology through collaborations with leading defense solution developers and key government agencies.

Today this Xilinx innovation is still the world's only single chip FPGA solution in production for Type-1 systems. Combined with its extensive development ecosystem, Xilinx SCC technology and security IP help shorten design cycles and reduce project risks. With Xilinx Spartan-6Q FPGAs, systems can accomplish what used to be unobtainable. These defense-grade Xilinx FPGAs are ideal for secure hand-held radios and other communications solutions. Unlike the alternatives, FPGAs offer a single-chip solution that enables reprogrammability with a click of a button. Devices become more cost-effective with the ability to support multiple protocols and formats, creating better user experiences even as communication requirements become increasingly sophisticated.

Besides offering unique Secure SWaP-C benefits, the Spartan-6Q FPGA family is part of a broad range of commercial, defense and space-grade devices. Off-the-shelf, ready-to-order Spartan-6Q FPGAs are rated to handle the operating temperatures of industrial (-40 to +100°C) and extended (-40 to +125°C) specifications. Standard lead content eliminates tin-whiskering concerns.

Time to market, reduced cost and risk mitigation are key to a programs overall success—making Xilinx defense-grade solutions the obvious choice. Developers can start out with Xilinx commercial-grade devices and later switch to 100% pin-compatible defense-grade devices with a seamless transition from prototyping to the low-rate initial production (LRIP) phase. And the inherent reprogrammability and functional flexibility of these FPGAs allow easier and faster design changes at any time.

Xilinx defense-grade solutions also include extensive development tools and support from industry-experienced operations and support teams. Aerospace and Defense is a top-tier market for Xilinx. Priority resources are dedicated to meeting the needs of next-generation applications. Come see Xilinx at MILCOM 2010, booth #1413 to learn more about Xilinx solutions for Military Communications or go to www.xilinx.com/defense.

About the Author: Colby Hoffman is the Senior Military Communications Architect, Xilinx Inc. (San Jose, Calif.). Contact him at more_info@xilinx.com

SPECIAL REPORT

FPGAs and SDR

"FPGAs are unquestionably a key enabling technology for software-defined radios," says Manuel Uhm, director, wireless communications at Xilinx in San Jose, Calif. "FPGAs provide the low latency and high performance required for today's wideband networking waveforms. An FPGA can provide the required performance for lower power consumption than DSPs, while providing the reconfigurability required to be software defined that ASICs can't support.

JTRS HMS and GMR enter gov

The Joint Tactical Radio System's Handheld, Manpack, Small Form Fit (HMS) system and Ground Mobile Radio system have entered the government testing phase. General Dynamics C4 Systems in Scottsdale, Ariz., is lead integrator on HMS; Boeing in Huntington Beach, Calif., leads the GMR effort.

"The JTRS HMS Program is in final integration and test," says Joe Miller, director of JTRS Programs for General Dynamics C4 Systems. "A great number of technical challenges with size, weight, and power (SWaP) are behind us, as is arguably the biggest technical challenge optimization of the networking waveforms to meet scalability, latency, voice quality, throughput, and other performance issues.

"There are a few minor challenges ahead with completing environmental, electro-magnetic interference (EMI), and security tests—however, these are viewed as relatively low risk," he continues." Remaining technical challenges beyond that focus on platform integration. This effort began in earnest for the U.S. Army Brigade Combat Team Integration Exercise (IBCT-IE) earlier this summer."

The direction of JTRS technology remains the same, Miller says. "That said there has been a consolidation of radio form factors for embedded platform applications. As platform development has matured, system requirements have matured and tighter constraints have been placed on the radio. Unique requirements and form factors have been eliminated to achieve smaller size and lower weight.

"There has been significant discovery with regards to what it takes

ernment test phase

to run and scale an ad hoc Soldier Radio Waveform (SRW) network," Miller notes. "The program was required to invest significant resources in optimization of this network. That capability was exclusively demonstrated on HMS in the BCT-IE this summer at White Sands Missile Range. In addition, the program has focused on getting initial capabilities to the field sooner so SRW, SINCGARS, and SATCOM have taken a priority over other waveforms.

General Dynamics completed development on the Joint Tactical Radio System HMS Production Rifleman Radio.

Regarding waveform development "General Dynamics is currently under contract to develop the Joint Tactical Radio System (JTRS) Mobile User Objective System (MUOS) waveform" Miller says. "In addition, General Dynamics C4 Systems has a full suite of waveforms that they have developed, which are currently fielded on the Navy's Digital Modular Radio."

HMS Small Form Fit A and Rifleman Radio

The HMS Small Form Fit A (SFF-A) has also "entered production in support of the Tactical Unattended Ground Sensor (T-UGS)," Miller says. "Development has completed on the HMS two-channel Manpack Radio and the product is in final integration and test to deliver an initial capability including SRW. The Manpack is currently in contractor development test verifying compliance to performance, environmental, and EMI requirements. This testing will complete in October 2010 triggering entrance into a Limited User Test (LUT) starting in December and completing in the February 2011. The HMS Manpack will complete security verification testing (SVT) in March 2011 which is the final gate for NSA certification. Based on this schedule, the HMS Manpack will enter low-rate initial production (LRIP) mid-2011."

General Dynamics completed development on the HMS Production Rifleman Radio (PRR) and "the product is in final integration and test to deliver an initial capability including SRW," Miller continues. "The PRR enters contractor development test in October 2010 to verify compliance to performance, environmental, and EMI requirements. The PRR will enter SVT December 2010 which is the final gate for NSA certification. In parallel with the Manpack LUT, the PRR will undergo a verification of corrected deficiencies test in February 2011 which will verify that the open issues from the Rifleman LUT have been addressed. Based on this schedule, the HMS PRR will enter LRIP mid-2011."

GMR status

In addition to the GMRs, Boeing produces the Wideband Networking Waveform (WNW), says Cheryl Sampson, external communications at Boeing. JTRS GMR is now in formal government testing, the final steps in the System Development

CONTINUED ON PAGE 16 ➔

SDR waveforms essentially are radio-related software applications that enable software-defined radios to perform specific functions, in much the same way that the Microsoft Word software application enables a desktop computer to perform word processing.

"FPGAs are used throughout the JTRS program but primarily in three applications—the digital front end (processing digital IF), the modem (PHY or baseband processing), and crypto (separate red or black side data movement)," Uhm says.

FPGAs are part of the framework of the software communications architecture (SCA), which is the framework for all JTRS radios, says Paul Quintana, senior technical marketing manager at Altera in San Jose, Calif.

CONTINUED FROM PAGE 15

and Demonstration phase prior to the decision on low-rate initial production.

JTRS GMR is part of the Brigade Combat Team Modernization (BCTM) network integration kits (NIKs) and underwent testing this summer, Sampson says.

During the tests, the NIKs were composed of the Integrated Computer System and the JTRS GMRs and powered by the most current battle command software, according to a Boeing release. The NIKs integrate and fuse sensor data to form the common operational picture from the solider up through brigade level.

The NIKs were fielded on Mine Resistant Ambush Protected (MRAP) vehicles that formed a network greater than 900 square kilometers and utilizing the most recent versions of the WNW and SRW, according to the release. The test demonstrated NIK-to-NIK communications using WNW at ranges exceeding 28 kilometers as well as on the move. The SRW also exceeded the threshold requirement for connection and transmission distance, Boeing officials say.

The FPGAs can work alongside the waveform processor—each waveform has a dedicated processor, he adds. The FPGAs would manage intensive signal processing functions and also can be reconfigured to handle new functionality, Quintana says. Altera also has multiple IP cores available for different signal processing applications.

Improving power management

While FPGAs offer the best flexibility and functionality at the chip level for SDR applications, they are not as power efficient as an application-specific integrated circuit (ASIC) which is not reprogrammable, Quintana says. Still, power efficiency within FPGAs is improving, he adds.

The major driving requirement coming out of the JTRS program today is to extend battery life by more efficiently managing power within the radios, Quintana says. Most of the time a JTRS radio is not at full power, but rather in static mode, which Quintana says "dominates battery technology."

Managing size, weight, and power (SWaP) for handheld battery-powered radios, such as the JTRS Handheld, Manpack, Small Form Fit (HMS) radio is tougher as they have more strict SWAP requirements, he adds. FPGAs manage power via external controls, such as lock rationing and other methods, Quintana says.

Quintana refers to an Altera white paper titled "Designing with Confidence for Military SDR Production Applications" for more information on how FPGAs manage power in military SDR applications.

Altera's Stratix III and Cyclone III FPGAs use their programmable power technology to minimize heat dissipation and cooling requirements by optimizing all circuits not on critical paths, in applications where batteries are not required, according to the white paper. For high-volume, power-sensitive applications like sensors or single-event upset (SEU)-sensitive systems in aircraft, Altera offers a path to logic-efficient HardCopy structured ASICs, a secure manufacturing process.

For small applications, Altera's "Cyclone III devices have enough resources in a single chip to

process advanced waveforms like SRW-CC (soldier radio waveform, combat communicator mode)," states the Altera white paper. Within the device multiple signal processing blocks and distributed memory eliminate "power hungry external memory components."

According to the white paper, "Cyclone III devices can implement entire waveforms under 1 watt, yielding a mission life of four times greater than current PLD implementations. With significant increases in waveform complexity, the majority of the functionality can now be optimized in Cyclone III FPGAs, eliminating the power of DSP devices from the digital electronics power budget.

Altera FPGAs are in SDR applications such as the JTRS Ground Mobile Radio system, Quintana says.

"The power story is a many layered one that requires focus on several levels"—transistor technology; FPGA architecture; designing for power; and system level design and integration, Uhm says. Xilinx has resources focused on all aspects of lower overall power consumption, from the system down to the transistors.

The Cyclone III FPGA from Altera can process advanced waveforms like SRW-CC—soldier radio waveform, combat communicator mode.

Xilinx's Virtex-6 FPGA family consumes 50 percent lower power and delivers 20 percent lower cost than the previous generations; the new family is built with a mix of programmability, integrated blocks for DSP, memory, and connectivity support—including high-speed transceiver capabilities, according to the Xilinx Web site. Xilinx Virtex-6 and Spartan-6 FPGAs are used in different parts of

SDR popular outside of JTRS program

While the JTRS program fueled the development of software-defined radio (SDR), it has moved into other military areas and into the commercial world with companies such as ZTE in Shenzhen, China shipping large numbers of SDR products, says Lee Pucker, chief executive officer of The Wireless Innovation Forum in Phoenix.

SDR systems are also found in other U.S. military programs and in Europe too, Pucker continues. For example, Harris RF in Rochester, N.Y., has been successful with its Falcon III line of software-defined radios and Rockwell Collins in Cedar Rapids, Iowa, and Thales in Neuilly-sur-Seine, France are developing their FlexNet radios for European applications.

The Harris Falcon III AN/PRC-117G, which is a wideband tactical radio that is both compliant with the JTRS Software Communications Architecture and NSA Type-1 certified, Harris officials say. The radio has been deployed by the U.S. Army and other services to mission areas.

The FlexNet radios are based on multi-band and multi-channel communication systems, designed with an open and secure architecture, compliant with the SCA standard, and will accommodate future

the JTRS program, Uhm says.

One layer is transistor technology, Uhm says. "There are many facets to this, but at a high level, Xilinx uses a low power process and multiple transistor sizes to minimize both static and dynamic power."

Within the FPGA architecture "Xilinx's DSP blocks greatly minimize power consumption over comparable DSP and other FPGA designs," Uhm continues. This would help manage power in modem designs, which are DSP intensive, he adds.

At the design level, Xilinx's "tool flows help designers to optimize designs for power," Uhm says. "In addition, Xilinx application engineers help customers optimize their designs through design optimization techniques, such as folding to reduce the size of the design, hence lowering static power consumption and cost by using a smaller device.

Although many companies do not focus on system-level design and integration, it "can have a much larger impact than any of the other focus areas," Uhm explains. "For example, integrating more discrete components into a single FPGA greatly reduces the total amount of IO in a system, which is where a significant amount of power is consumed. In order to do this effectively, the semiconductor vendor needs to have a system level understanding when working with its customer."

Cognitive radio

Software-defined radio created a paradigm shift in military communications and the next evolution in military communications is likely to technology insertions and capability upgrades, according to a Rockwell Collins release. End users can develop and download their own waveforms into the radio.

The FlexNet device has been selected for European applications, most recently by Swedish FMV for FlexNet-Four SDRs to support the country's Tactical Data Radio System (TDRS) program for advanced ground mobile communications, according to a Rockwell Collins release. The FlexNet platform has been selected by the European Secure software-defined Radio (ESSOR) program to support the new European Coalition Waveform.

"The FlexNet-Four radio provides the TDRS with the ability to handle larger networks while providing the Swedish Armed Forces with mobile wireless networking in a self-contained communications system," says Bruce King, vice president and general manager of Surface Solutions for Rockwell Collins, in the release. "The FlexNet-Four embraces the same objectives envisioned by the U.S. Joint Tactical Radio System program and supports real-time, network-centric operations and enhanced interoperability."

An SDR's open architecture also makes the devices cost-efficient by using an open architecture design that enables technology refresh.

be in cognitive radio.

Cognitive radio is "capable of understanding its environment and can adapt based on user needs/preferences in accordance to radio policies and etiquettes that exist in the user's operational area," says Byron Tarver, director of Radio Systems Engineering for General Dynamics C4 Systems in Scottsdale, Ariz.

"Based on its potential, some examples of how cognitive radio would be beneficial to the military include: efficient use of spectrum with limited frequencies available; improvements in quality of service; and adaptive channel identification to prevent jamming," Tarver says.

The Virtex-6 and Spartan-6 FPGAs from Xilinx are used throughout the Joint Tactical Radio System program.

"The definition of cognitive radio can vary," Xilinx's Uhm says. "For the Wireless Innovation Forum, the definition of a cognitive radio is as follows: 'Cognitive radio is a radio in which communication systems are aware of their internal state and environment, such as location and utilization on RF frequency spectrum at that location. In general, cognitive radios use software-defined radio technology to modify their operating parameters to meet the objectives of the user with a common set of radio hardware.'"

The concept of cognitive radio is being advanced but actual cognitive radios have yet to be deployed, Pucker says.

Early work in cognitive radio is proceeding through the Federal Communications Commission (FCC) in an effort to develop unused television frequency spectra, Pucker says. For example, if someone were to turn toward channel 68 and get nothing but static, that is an unused TV frequency spectrum, he adds.

The FCC's goal is to use cognitive radio to bring modern communication services to remote areas, but this same concept could be

applied to military applications too, Pucker says. Cognitive radio could enable military radios in harsh, remote environments such as a desert to more efficiently access parts of the spectrum—also called dynamic spectrum analysis, he adds.

The Defense Advanced Research Projects Agency (DARPA) is exploring cognitive radio technology in the Next Generation (XG) Communications program, Pucker says. XG develops technologies to enable dynamic access to the radio-frequency spectrum, according to the DARPA Web site.

"Cognitive radio is still in its infancy," Tarver says." We have demonstrated many of the concepts and there is a whole range of protocols and etiquettes that have to be agreed upon. The development community must come together with standards that define the use of the radios as well as regulatory agencies weighing in.

"At this point, General Dynamics C4 Systems is working to implement capabilities such as spectrum awareness and management and is looking at several others," he adds.

DARPA researchers are also asking industry to design extremely efficient monolithic signal-recognition integrated circuits (ICs) for next-generation military cognitive radio, radar, and electronic warfare in a new DARPA broad agency announcement (DARPA-BAA-10-77) for the Cognitive radio Low-energy signal Analysis Sensor ICs (CLASIC) program.

CLASIC will develop new kinds of RF, analog, and mixed-signal integrated circuit architectures and design techniques for cognitive radio—or smart communications able to sense RF propagation conditions and the needs of users, and adapt its transmit and receive parameters to achieve the best possible quality of service, according to the DARPA Web site.

Signal parameters of interest for the CLASIC program include modulation schemes, signal constellations, multiple access or hopping schemes, channel use, and demodulated symbols. CLASIC is part of the DARPA Adaptive RF Technology (ART) program.

The waveform processing requirements of emerging military cognitive radio systems are pushing A/D converter and digital signal processor (DSP) capability, as well as algorithm complexity, beyond the state of the art of today's integrated circuit technology, DARPA officials say. To fill the gap, the CLASIC program seeks to design new kinds of communications integrated circuits with the capability and energy efficiency to act as a cognitive radio signal sensor on a chip.

Primary aims of the CLASIC program include developing energy-efficient analog and/or mixed-signal processing techniques for separating and analyzing mixtures of complex signals. These techniques may require blind source separation using RF adaptive recursive and transversal filters; analog implementations of fast Fourier and wavelet transforms; and efficient implementations of signal feature extraction and classification algorithms in analog/neuromorphic processing blocks.

TECHNOLOGY FOCUS

Electronics to the extreme

Industry innovations aid electronics systems designers and integrators grappling with thermal management challenges in mil-aero environments.

BY **Courtney E. Howard**

The SprayCool Multi-platform enclosure, MPE-3U, from Parker Hannifin sports an integrated heat exchanger.

Few issues plague military and aerospace systems designers, developers, and integrators as persistently as thermal management. Size, weight, and power (SWaP) constraints are challenging, but they also exacerbate the thermal management problem. At the same time, mil-aero electronics are employed in a vast array of environments, each with unique challenges—be they sand, snow, humidity, or temperature highs and lows. Today's mil-aero electronics must withstand the extremes of deserts and space, and virtually everything in between.

"Thermal management is absolutely critical in military and aerospace environments," says Curtis Reichenfeld, chief technical officer at Curtiss-Wright Controls Electronic Systems in Santa Clarita, Calif. "Functionality, reliability, and safety require maintaining electronics within qualified temperature limits."

"We all know that heat can adversely affect the performance of electronics," says Dr. Erich Buergel, general manager of the Mentor Graphics Mechanical Analysis Division (formerly Flomerics) in Frankfurt, Germany. "Minimizing weight and optimizing space are always key design goals, but an effective cooling solution is essential to reliability. Since field failure is not an option, thermal management is of utmost importance for mil/aero applications."

Hot topic

Several trends are influencing thermal management in mil-aero environments. "As we automate more functions to minimize the need for human involvement, we are increasing our reliance on electronic devices," admits Buergel. "This, in turn, creates a need to design smaller electronic packages, as well as components that fit into tighter spaces.

"At the same time, chips and IC packages are becoming more powerful. Lastly, most devices used for mil-aero applications now must be self-contained/air-tight to ensure contaminants do not enter the device and adversely affect performance," Buergel adds. "The increased density that results from fitting more powerful components into smaller air-tight spaces creates heat dissipation problems."

On the business side, those serving the mil-aero community are "urgently pursuing cost-saving measures to deal with today's economic and market realities," Buergel says. "Due to the complexity of electronic products for mil-aero applications, plus the safety and regulatory issues that uniquely affect them, saving costs is not easy."

CFD and avionics

Component designers and systems architects are increasingly turning to electronic design automation (EDA) to reap cost saving and timesaving benefits. EDA software tools enable

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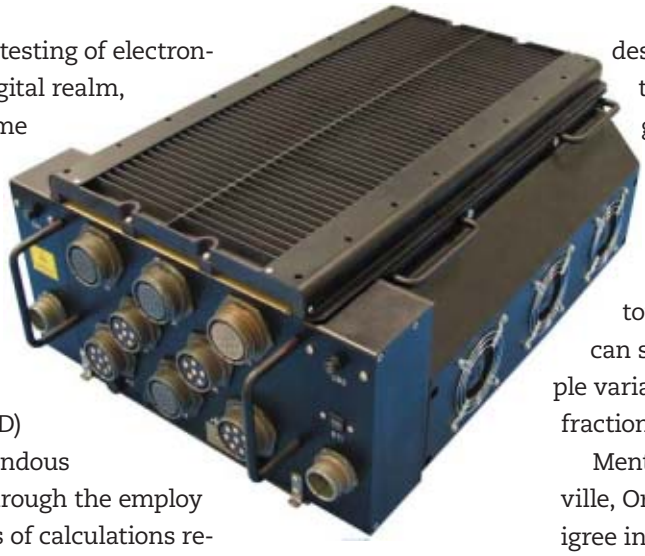
the design, simulation, analysis, and testing of electronic components and systems in the digital realm, rather than investing considerable time and money in crafting physical prototypes. "Simulation is proving to be the salvation of manufacturers working under pressure to deliver end products of proven quality at lower cost and in less time," Buergel says.

Computational fluid dynamics (CFD) software, in particular, saves a tremendous number of engineering man hours through the employ of algorithms to perform the millions of calculations required to analyze and solve problems that involve fluid flows—such as the movement of air throughout an electronics enclosure, Buergel says. "CFD simulation is one of the most reliable methods of understanding and managing thermal issues. Not surprisingly, CFD has become a cornerstone of aerospace mechanical design. With CFD simulation, manufacturers can greatly reduce the cost of getting a product out to market." For example, instead of testing multiple physical prototypes, design engineers can simulate and test multiple variations of the design in a fraction of the time and cost.



Curtiss-Wright Controls Electronic Systems engineers designed a chassis to meet the requirements of the Northrop Grumman Advanced Mission Management System for the Broad Area Maritime Surveillance Unmanned Aircraft System program.

Mentor Graphics in Wilsonville, Ore., has a strong pedigree in electronics cooling, Buergel says, given that the company's software simulation tools have been employed in thermal simulation applications for more than 22 years. Of late, mil-aero systems designers have increasingly adopted the Mentor Graphics FloEFD software with Concurrent CFD technology.

The tool embeds within mechanical computer-aided design (MCAD) platforms, bringing thermal analysis inside the digital design environment. FloEFD automatically prepares the design model in a host MCAD system for CFD analysis, and requires no special user training. "This process saves engineers time because they no longer need to outsource their designs to CFD specialists for evaluation. Mechanical designers can now perform accurate thermal analysis routinely without leaving their accustomed MCAD environment," Buergel explains.

Mentor Graphics' FloTherm plots airflow direction (shown with arrows) and temperature or velocity data (with color) for enclosures.

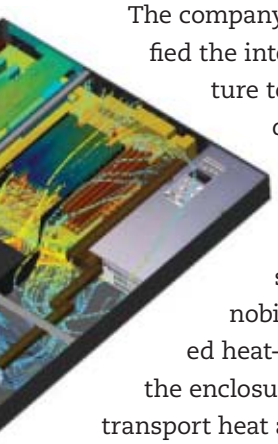
All in all, thermal management is a major challenge from the very first design phase and it can be a significant design bottleneck, Buergel admits.

Cooler chassis

Tecnobit, an industrial and defense electronics company in Madrid, Spain, designed a special chassis to

house cockpit avionics in an enclosure whose maximum dimension was approximately 10 centimeters, or 4 inches. The system was designed to be completely sealed without any ventilation slots, requiring heat transfer through the outside surface by conduction, radiation, and natural convection. Tecnobit's preliminary design did not meet the design requirements; it was unacceptable from a thermal standpoint and conflicted with the trend toward higher power and heat dissipation in avionics systems.

Tecnobit's design team employed FloTHERM to evaluate avionics chassis design options in virtual form, with no need for expensive, time-consuming hardware prototypes. The simulations enabled the Tecnobit engineers to optimize the thermal design rapidly, while observing the effects of their design changes.

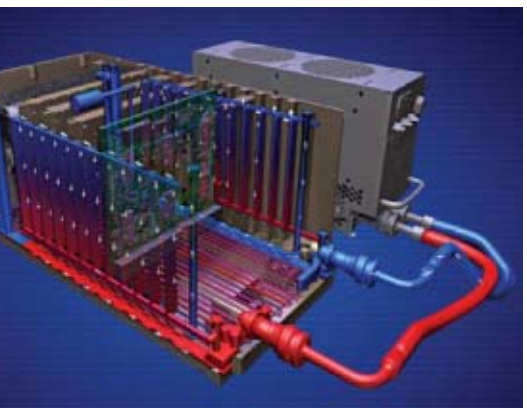


The company's engineers modified the internal chassis structure to increase heat conduction from the components to the chassis walls. At the same time, the Tecnobit design team added heat-dissipating fins to the enclosure's outer surface to transport heat away from the box. Sand-blasting treatment and electrostatic painting further enhanced convection and radiation exchange with the external ambient air. Tecnobit engineers used FloTHERM 3D thermal simulation to perform steady-state and transient thermo-fluid simulations, and predict system thermal behavior as various heat-conduction refinements were added. Ultimately, the team reduced component junction temperatures by 40 degrees Celsius compared with the initial design.

Mentor Graphics' FloTHERM spans applications ranging from evaluating sealed electronic modules to predicting airflow in server racks and blade enclosures. FloVENT tracks the flow of cooled or heated air through vehicles and buildings. The MicReD T3Ster (Trister) hardware measurement tool characterizes thermal impedances over an entire heat path—from the semiconductor junction

that generates the heat to the outermost system housings and into the ambient—for the design of lighting and laser systems, printed circuit boards, and electronic enclosures.

The company's FloEFD Concurrent CFD tool set spans various mil-aero applications, including modeling the flow of liquids and gases, as well as evaluating aerodynamic surfaces. It has been used in the development of a micro aerial vehicle concept, in the evaluation of "nose pod" cooling and aerodynamics for a military reconnaissance aircraft, and in evaluating a nitrogen-injection feature for the fuel tanks in a Bell Helicopter military rotorcraft.



Parker Hannifin delivers thermal management solutions such as the above Liquid Flow Through (LFT) chassis and Heat Rejection Unit (HRU).

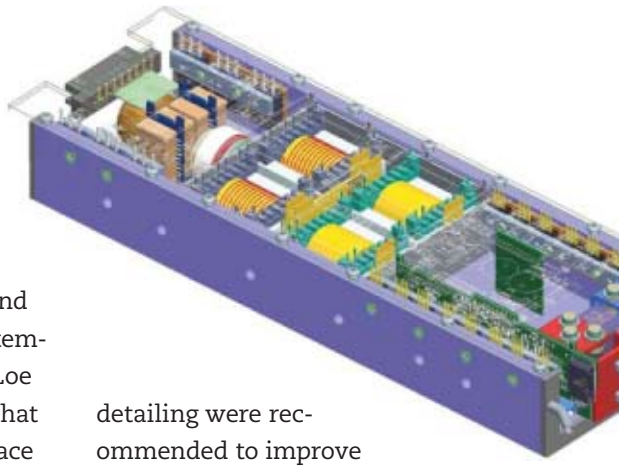
Helicopter heat

Engineers at Bell Helicopter, a Textron Company in Fort Worth, Texas, used the Mentor Graphics FloEFD for helicopter inlet temperature distortion modeling. "Flight testing revealed some marginal engine inlet air temperature distortion levels, so CFD was used to try to identify the culprit," says David H. Loe, principal engineer, Bell Helicopter Textron.

"It was assumed that either hot gas re-ingestion or inlet air heat transfer was the root cause, so we set up a helicopter model that simulated the problematic flight condition. Exhaust re-ingestion did not initially appear to be likely based on the CFD, so we added heat transfer to the model and applied some ballpark surface temperatures to the engine inlet," Loe explains. "We quickly learned that it was highly possible that surface heat transfer to the incoming fresh air could be taking place and modified the CFD model to simulate insulation on some of the inlet surfaces. The 'insulated' model showed improved inlet temperature distortion levels, so the flight test aircraft was ultimately outfitted with insulation blankets on critical surfaces identified in the CFD model." The software tool enabled the team to overcome time constraints associated with a test program and to model complex geometry in a short time.

FloEFD also aided Bell engineers in helicopter oil cooler airflow management modeling. "Space constraints forced a non-standard, blower-to-heat exchanger air duct, with rapid diffusion and some awkward, undesirable twisting of the duct," Loe describes. "The primary concerns were: excessive total pressure losses in the ducting that would adversely affect the cooling blower airflow rate and non-uniform air distribution at the cooler core inlet face that would result in poor cooler heat rejection characteristics.

"The CFD model helped identify the areas within the ductwork where the flow was separated from the surface, and to clarify the system total pressure losses," Loe continues. "Some changes to the duct detailing were recommended to improve the airflow characteristics and flow uniformity at the cooler inlet face." In the end, the simulation tool enabled the team to model complex internal airflow geometry, and to work an airflow system into an area with a high level of packaging constraints.



TDI Power's LiquaCore power module "wraps" electronics in a cold plate through which cooling liquid is flowing.

Chassis considerations

Effective thermal management at the chassis/system level requires detailed knowledge of the platform storage/operating environments, as well as the system power dissipation and available cooling options, Reichenfeld notes. Electronic assemblies are designed to maintain component junction and die temperatures within specified limits. The chassis/system design must consider cooling methods to dissipate the heat into the operational environment from electronics thermal convection/conduction paths, he adds.

Extreme cold- and hot-start requirements are the challenge with commercial off-the-shelf (COTS) components that are typically limited within -40 to 71 degrees C operation at the system level. "Careful consideration of the criticality of the system is necessary to determine the

effects caused from a loss of heating/cooling on functions provided to the platform," Reichenfeld says. "In some cases, redundancy and loss of cooling analysis is necessary for safety and mission-critical elements to prevent loss of life."

A forced air chassis from Hybricon Products, part of Curtiss-Wright Controls Electronic Systems, houses conduction-cooled electronics in a current airborne application at 50,000 feet. The modified 1-ATR-tall chassis includes a 6U, 13-slot custom Hybrid VME64x-VXS-OpenVPX backplane with a 1400-watt, MIL-grade power supply and two MIL-grade fans. The application required a high-performance heat exchanger due to very high power dissipation.

TDI Power's 30-kilowatt power system includes LiquaCore power modules and electrical and water connections.

Unmanned electro-optics

Unmanned systems, whether in the air or on the ground, are delivering much-needed information and soldier protection on the increasingly digital battlefield. Armed with sensitive electro-optics, such as sensors, unmanned vehicles often venture into and persistently survey harsh environments, gathering mission-critical data while helping to keep warfighters out of harm's way. Unmanned systems' thermal management needs are nearly as complex and intricate as their compact electronics, however.

Curtiss-Wright Controls Electronic Systems in Santa Clarita, Calif., is designing the next-generation chassis for Northrop Grumman's Advanced Mission Management System (AMMS) for the Broad Area Maritime Surveillance

Unmanned Aircraft System (BAMS UAS) program. The BAMS UAS will provide the U.S. Navy with a persistent maritime intelligence, surveillance, and reconnaissance (ISR) system to protect the fleet and provide a capability to detect, track, classify, and identify maritime and littoral targets. The chassis has six integral cooling fans providing air flow for up to 800 watts power dissipation at 55 degrees C. AMMS operation is critical to the mission objectives and protection of U.S. Navy fleets during operations, Reichenfeld describes.

Dontech in Doylestown, Pa., has also recognized the need to maintain electronics at optimal operating temperatures. The company launched its Therma Klear transparent heaters to provide the warmth necessary to extend the operating temperature of liquid crystal displays (LCDs) in cold environments (from 0 degrees to below -40 degrees C) and for the anti-fog, anti-icing, and de-icing of optics and optical camera, sensor, and display assemblies.

A Therma Klear heater, composed of an electrically conductive thin-film coating on a transparent substrate, generates heat when current flows across the coating. Dontech heaters employ different types of crystalline materials (e.g., zinc sulfide or germanium), glass, acrylic, and polycarbonate substrates. Applications include avionics displays, vehicle displays, mobile computers, and handheld devices.

Heat-dissipating designs

Thermal management of military and aerospace electronics continues to be one of the foremost challenges facing design teams, admits Ivan Straznicky, principal engineer and technical fellow at Curtiss-Wright Controls Embedded Computing (CWCEC) in Ottawa, Ontario. "The desire to use the latest generation, multicore processors to meet the performance needs of ever more sophisticated applications are driving power dissipation levels and densities beyond what was once considered unachievable in mil-aero electronics.

"In order to make use of these high-performance processors in standard circuit card cooling configurations (e.g., conduction cooling), thermal engineers are painstakingly re-examining every element of thermal designs to eke out enough improvement for successful products," Straznicky adds. "Without such improvements, the use of these processors would be limited to lower speed grades and/or more benign environmental conditions (e.g., lower allowable card edge temperatures). Even with such improvements, the cooling ability of standard configurations, such as conduction and forced air over components, is not infinite and is quickly reaching limits of the governing physics (e.g., material properties, airflows)." Continued innovation at all levels of heat removal, in particular the chassis and system levels, is required to optimize their capabilities to efficiently remove heat to ambient environments, he says.

High-density processing solutions, such as those designed and developed by CWCEC, require highly efficient cooling solutions to meet challenging mil-aero environments.

Most of the company's card-level products are designed to standard cooling configurations, such as forced air over components or conduction cooling; however, some of its cards can now dissipate approximately 4X the heat compared to a decade ago, with similar boundary conditions, Straznicky says. CWCEC engineers have also worked with customers and partners to develop and design products using such advanced cooling technologies as spray cooling, air flow through cooling, and liquid flow through (LFT) cooling. In fact, engineers at CWCEC and Parker Hannifin Corp. in Cleveland, Ohio, developed an LFT prototype capable of cooling over 650 watts of power using 55 degree C Polyalphaolefin (PAO) coolant.

Liquid cool

Parker Hannifin has expanded its portfolio of liquid thermal solutions with the acquisition of SprayCool in Liberty Lake, Wash. The company's newest mil-aero applications center on liquid-cooled electronics enclosures and two-phase cold plate solutions.

"We continue to see more demand for both conduction-cooled enclosures that are side-wall cooled with single phase liquid, such as ethylene glycol and water (EGW) or PAO, coupled to a remote Heat Rejection Unit (HRU), and SprayCool enclosures where we take advantage of direct-spray and the evaporative cooling process on the electronics inside a sealed enclosure," explains Joe Baddeley, business development manager, Parker Aerospace, Thermal Management Systems Team.

"Sensor and image processing applications that utilize standard 6U board form factors are still leading the pack in terms of liquid cooled enclosures, but we are seeing a lot more proposals and trade studies for smaller 3U systems, especially with the release of VPX and the ability to push more power into these smaller modules," Baddeley notes.

Two-phase cold plate solutions are being employed in power electronics and radar applications. "In both applications, the trades and early development units are showing the potential for not only improved thermal performance and subsequent reliability gains over air or single phase liquid cooling at the electronics level (IGBTs, power amplifiers, transmitter modules), but also the ability of pumped two-phase systems to accomplish the task without the need for larger vapor compression systems (VCS) or chillers," Baddeley continues. "Thermal efficiency gains realized with two-phase cooling give the integrator the best chance at reducing or eliminating the need to chill down the coolant before it enters the electronics assembly."

Venerable vetronics

Cooling and thermal management have become the biggest challenge for military electronics due to: significantly increased power levels, more severe environments, and condensed schedules with a desire for COTS, explains Mike Henderson, director, military and aerospace products at TDI Power in Hackettstown, N.J.

"Regardless of whether it's an aircraft, vehicle, or shipboard application, the power loads for new command, control, and communications (C3) systems, counter-weapon systems, and other applications being developed are driving the need for better thermal management," Henderson says. "More power means more heat, which has to be dissipated and managed efficiently. In addition, you have traditionally non-electric, belt driven systems being electrified to improve reliability and lower the overall weight of the particular platform. Very simply, without innovative thermal management techniques for power electronics, the military will not be able to field the new systems or hybrid platforms currently being developed."

COMPANY INFO

Curtiss-Wright Controls Electronic Systems
www.cwcelectronic systems.com

Curtiss-Wright Controls Embedded Computing
www.cwcembedded.com

Dontech
www.dontechinc.com

GrafTech International
www.graftech.com

Honeywell
www51.honeywell.com

Meggitt Defense Systems Inc.
http://mdswebmaster.com

Mentor Graphics
www.mentor.com

Parker Hannifin
www.parker.com

RINI Technologies Inc.
www.rinitech.com

TDI Power
www.tdipower.com

Thermacore Inc.
www.thermacore.com

Environmental conditions for electronics are getting worse; mil-aero systems are exposed to water egress, blowing talcum-powder-like sand, high levels of shock and vibration, and operating temperatures that range from Artic conditions as low as -46 degrees C to in excess of 149 degrees C near engines that are dissipating very high levels of heat. In the latter situation, "we actually have to insulate the power electronics to keep heat out," Henderson reveals. "In these conditions, simple convection cooling using blown air is just not an option, as the fans would have to be very large and noisy blowing contaminants that would quickly render them useless, thus disabling the very systems they were meant to cool."

TDI Power's DC-DC or DC-AC products, employed in military ground vehicles, are typically mounted below the fording plane, which means the power electronics must be completed sealed. Liquid cooling is the only feasible way to cool such high-power products that can be upwards of 30 kilowatts, Henderson says. The company's LiquaCore technology employs liquid cooling from the vehicle's coolant system to dissipate heat away from sensitive electronics in a modular, scalable architecture. A typical LiquaCore module "wraps" the electronics in a cold plate through which cooling liquid is flowing in multiple, parallel passageways. Power semiconductors, magnetics, and PC boards come in direct contact with the liquid-cooled metal housing for maximum cooling efficiency.

The ability to cool electronics with a water/glycol mix at a typical temperature of 80 degrees C enables TDI Power engineers to use materials already present on the vehicle and to avoid the addition of relatively unreliable fans or heavy, heat-dissipating plates, Henderson explains. "With LiquaCore, we can quickly configure a power solution using standard modules in a customized outer skin that meets the end users' available space claim. For example, the power conversion system can easily be mounted in the V-shaped undercarriage of vehicles like MRAPs (Mine Resistant Ambush Protected vehicles)." A power-conversion system configured with LiquaCore modules is also well suited for hybrid or all-electric vehicles in which tightly regulated DC power is needed for on-vehicle applications or AC power is required to meet off-vehicle needs.

Hot under the collar

Soldiers and soldier borne electronics, especially those deployed in desert environments, require innovative and exceedingly compact and efficient thermal management tactics. Engineers at RINI Technologies Inc. in Oviedo, Fla., have developed a miniature refrigeration product weighing less than 4 pounds.

The primary application for the refrigeration unit is personal cooling, yet it has been adapted to cool small lasers and electronic modules operating in hot military environments. "When a laser or electronics module is unable to operate in hot environments, our technology is increasingly one of the only solutions to provide the needed cooling without exceeding typically strict size and

weight budgets," says Dr. Daniel P. Rini, president of RINI Technologies.

Frigid, final frontier

Space represents a very challenging environment for electronics, considering its extreme thermal conditions, radiation hazards, costly and remote maintenance, and so on. Technology firms continue to innovate in an effort to warm electronics in the absence of solar heat and to shield systems from the intense heat emitted from rocket motors.

Engineers at NASA's Jet Propulsion Laboratory (JPL) sought the most efficient and maintenance-free methods to dissipate heat from the Moon Mineralogy Mapper's (M3's) sensitive electronics, which enable the instrument to identify lunar minerals from orbit 100 kilometers above the moon's surface. Staff at the k Technology Division of Thermacore Inc. in Langhorne, Pa., helped JPL engineers not only develop thermal specifications for optimum rejection of high heat loads from the M3, but also design a system that would work without the need for maintenance or adjustments.

Thermacore also delivered six radiator panels, featuring the company's patented k-Core advanced, high-conduction composites to reject excess heat into space. Thermal straps, also fabricated by Thermacore's k Technology Division, were used as heat spreaders within the instrument. In addition, k Technology team members tested the completed components to ensure compliance with performance objectives, such as meeting the most rigorous specifications in the unique environment of outer space.

High heat

Engineers at Aggreko plc, headquartered in Scotland with a support center in Houston, Texas, are working with Alliant Techsystems (ATK) staff to test Development Motor-2 (DM-2), NASA's second Ares five-segment solid rocket motor. Aggreko's low-temperature chillers were used to execute the

DM-2 "cold motor" test, supporting NASA's specification to cool the motor to 40 degrees F to measure solid rocket motor performance at low temperature and verify design requirements of new materials.

"This project was unique due to its many special requirements," says Steven Bukoski, project manager for Aggreko Process Services, a process engineering group within Aggreko. "Aggreko's specialized, large-capacity portable equipment and skilled technicians were critical factors in successfully achieving freezing temperatures under challenging environmental conditions, such as hot summer temperatures, cooling 1.6 million pounds of propellant, and working with a movable structure."

Aggreko process engineers and temperature control experts used specialized temporary utility equipment to cool the structure to target temperatures of 20 degrees F. Aggreko's engineered solution for the cold motor test consisted of temporary generators to power a system of low-temperature chillers, specially designed low-temperature air handlers, a customized air-conditioning duct system, and a suite of temperature control and electrical distribution equipment.

Aggreko designed a first-of-its-kind low temperature air handler configuration to manage climate control for the mobile building: three stacks of two air handler units with a custom-made defrost unit. One of the air handlers drew air from inside the building, cooled it to 20°F, then recycled into the building while the remaining unit was on standby or defrost mode, enabling continuous cooling of air. A seventh air handler was installed to provide fresh air and positively pressurize the mobile building to eliminate infiltration of warm, moist air.

RINI Technologies' compact, portable cooling unit connects to a soldier's vest to provide personal cooling in a variety of mil-aero environments.

Cooling choices

The approaches to cooling mil-aero electronics vary widely and depend on many factors: platform type and location of electronics, operating environments, environmental control system (ECS) capacity, SWaP considerations, and power/heat density, for example, says Straznicky. "That said, the established trend of rising power levels per unit area (heat density) of circuit cards, driven by higher power/density processors and component miniaturization, has led to the increased use of advanced cooling approaches like air flow through and liquid flow through. In parallel though, innovations in standard COTS cooling approaches, like conduction cooling, continue to meet the challenge of this heat/density increase, and thereby reduce the risks associated with implementing some of the advanced approaches. This is important as there are trade-offs required for the use of advanced cooling approaches."

"The need for more power, lower weight, better reliability, and cost containment require very innovative solutions as these factors typically work in conflict with each other," Henderson admits. "Liquid cooling provides a huge advantage over fan-cooling or pure conduction cooling."

"In relatively lower-power applications, air cooling will continue to dominate as it is low cost and simple to implement," Baddeley admits, "but in electronics applications where power densities are high, environmental conditions are extreme, and platforms are constrained by size, weight, and power, we will continue to see more mil-aero users rolling out both single- and two-phase thermal management solutions.

"Mil-aero customers still want and expect integrators to do their best to keep the electronics cooling solution simple, and liquid cooling will always add complexity over air cooling," Baddeley adds. "The difference now is that as cost and complexity of liquid-cooling solutions come down and the size, weight, and power

benefits gained by reducing the need to chill down massive amounts of air required to otherwise cool the electronics becomes more obvious, end users are increasingly becoming more accepting of advanced cooling solutions. That is, we are seeing more platforms and programs recognizing that the SWaP benefits are too good to ignore in relationship to the complexity factor."

Today's mil-aero end users maintain their focus on size, weight, power, and cost (SWaP-C), says Reichenfeld, "so thermal management considerations are optimized to minimize these parameters, while maintaining operational performance in severe thermal environments. The thermal aspects of a system are considered at a platform level and impacts are determined in regards to cooling methods and burdens placed on the environmental control system contribution. Liquid-cooled chassis provide the highest thermal density in the smallest package size; however, this needs to be balanced against the SWaP-C of pumps, reservoirs, and heat exchangers at a vehicle level."

No matter one's thermal management preference, "industry will continue to innovate and provide high-performance, thermal management solutions to deal with high power dissipation with reduced size and weight," Reichenfeld enthuses.

Thermal management of mil-aero applications continues to meet the challenges of higher power/density electronics; however, more innovation is required if this is to last, Straznicky says. "Fortunately, many developments are underway that are likely, in combination, to allow the continued use of high-performance electronics in mil-aero applications and environments. These developments span a number of areas, including new materials, optimization of legacy cooling methods, and maturation of cooling approaches."

OPINION

Understanding OpenVPX: a closer look at interoperability for VPX systems

BY **Justin Moll**

The VPX architecture has been successful since its inception in 2007. With its high-speed performance using the MultiGig connector, wealth of available I/O, rugged form factor, and design flexibility, it has taken the military and aerospace industry by storm. In late 2008 and early 2009, grumblings about the architecture's wide-open flexibility creating interoperability issues turned into a loud chorus. Therefore, the OpenVPX initiative commenced in early 2009, with a goal to provide interoperability definitions for the VPX specification.

The initiative was rolled into the VMEbus International Trade Association (VITA) as the VITA 65 specification, which is expected to go through ANSI approval in June 2010. It would take too much text and likely to be too confusing to go through every aspect of OpenVPX, so we will focus on the technology from the backplane perspective.

OpenVPX simply provides definitions for backplane configurations and the module and slot profiles that are used therein. The module and slot profiles ensure that a vendor's VPX boards have pinouts that are interoperable within the VPX backplane slots. The backplane configuration tells the user which slot profiles are used, including the data rate, routing topology, and fabric used.

Functionally on the backplane, the whole 425-page specification only changes two pins. OpenVPX redefined two reserved P0/J0 signals Aux_Clk (+/-) and added one P1/J1 single-ended utility signal of Maskable Reset and redefined the Res_Bus signal to GDiscrete. The Aux_Clk and GDiscrete pins were already bused anyway, so there is minimal effect. The SysCon signal is also now configurable; however, the OpenVPX effort isn't really about functional changes, it's about definitions.

Defining backplane configurations

For the backplane, the backplane topology chart is a good starting point on the overall composition of its design. It shows the topology across the expansion plane, data plane, control plane, and system management (IPMB) and utility buses. From here, we can learn quite a bit about the layout of the backplane. The topology across the data plane will let us know the core fabric topology, like whether it's a star, ring, or mesh design. Next, we need to look at the backplane profile to understand what types of specific slots it contains.

The backplane profiles tell us what slot profiles are incorporated, the pitch, and the data rate. The profile name gives us some basic information about the backplane. So, in the 3U backplane example, this is its profile name: BKP3-DIS06-15.2.14-1

BKP = backplane
3=3U
DIS = Distributed mesh topology
06=6 slots
15.2.6 = VITA 65 specification section location of this configuration
-1 =

The profile segments, such as height, slots, and location, in the specification are easy to figure out. The "DIS" in the part number may be more confusing. The main fabric topologies are CEN for Centralized, DIS for Distributed, and HYB for Hybrid. "Centralized" means it has a centralized switch slot and the routing could be similar to a Star topology. "Distributed" has the interconnections across the slots like a mesh or a ring. "Hybrid" in this case refers to a hybrid of serial VPX slots and parallel slots like VME64x (CompactPCI is another possibility, too). In our 3U backplane example, the

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backplane topology chart showed a "five-slot ring", which is a twisted ring routing design. In the backplane profile number, we know that this is defined as a Distributed architecture.

The backplane profile summary in the specification also describes the slot types (payload, switch) and the communications plane topologies which describes the number/type of signal (fat pipes, thin pipes, ultra thin) across the control, data, and expansion planes. The slot type is also further defined. The DIS and CEN configurations typically have Payload and switch slot types. The HYB will typically also define Peripheral, bridge, and bus slot types like VME to account for connections to the legacy bus slots. The Bridge slot does not mean an active bridge board (like a CompactPCI Bridge) is being used; it refers to the fact that this VPX slot has pinouts defined for the parallel bus (like VME).

Defining modules and slot profiles

VPX Modules will utilize different type of signal links, such as Fat Pipes with 4 links (4 Tx pairs + 4 Rx pairs), Thin Pipes with 2 links, and Ultra Thin pipes with one link. The wider bands like Fat Pipes are typically used in the data plane, while the control plane will often have the thin pipe or ultra thin-pipe signals. OpenVPX provides definitions for the payload and switch slot modules.

So, when we look at the backplane topology, backplane profile, and the corresponding slot profiles, we can understand how a VITA 65 backplane is configured. With this information, we can see which cards, with specific slot profiles, are compatible with each backplane.

It's not only important for your backplane provider to understand the OpenVPX configurations, it's critical they understand the VPX ecosystem. Issues such as cooling and board specifications and configurations are critical to VPX success.

Make sure your provider is familiar with the associated industry products lines, design considerations, and potential pitfalls of the full VPX ecosystem. It's important to remember that not all VPX backplanes need to be or will be compliant to VITA 65 (OpenVPX).

PRODUCT intelligence

Design trends in backplane enclosures revolve around high performance, small size, and thermal management

BY **John Keller**

When it comes to backplane enclosures and chassis for embedded computing applications, things are getting smaller, hotter, and more powerful, which is putting pressure on technological approaches like small rugged connectors, advanced thermal management, and the latest high-speed serial switch fabrics.

Designers and integrators of embedded systems, more than ever before, are demanding higher performance in smaller packages; extremely low-cost and low-power processors and circuit cards; the most efficient thermal management possible in the smallest packaging possible, and even backplane enclosures and board products that are smaller than today's 3U systems.

"There are two classes of CPU architectures going into embedded systems—really high performance or really low-power applications," says Bob Sullivan, chief technology officer of Hybricon Products, a Curtiss-Wright Controls Electronic Systems company in Littleton, Mass.

"One of the trends we see is smaller form factors and higher performance. New architectures such as 3U VPX are very attractive for applications such as UAVs [unmanned aerial vehicles] and small robotics," explains Justin Moll, director of marketing at Elma Bustronic Corp. in Fremont, Calif.

Functional densities of embedded computing power continue to shrink as systems designers seek to cram ever-more computing power onto small platforms such as UAVs, ground robots, and soldier systems. The other side of that coin, however, involves small systems where performance is not so much an issue as is cost and low power consumption.

"The other trend is a very SWaP [size, weight, and power]-constrained, low-power computing solution that is small, light, and inexpensive. This seems to be something people want to leverage," says Jacob Sealander, chief architect of embedded systems at Curtiss-Wright Controls Embedded Computing in San Diego.

Small size and low power usually mean high heat, which in backplane enclosures and chassis is putting a premium on electronics cooling and thermal management. Complicating this picture is the widespread adoption of the latest powerful microprocessors from Intel Corp., which tend to be hot chips. The push to small form factors also puts pressure on making systems rugged.

COMPANY INFO

AbelConn LLC
www.abelconn.com

Ampro ADLINK Technology Inc.
www.adlinktech.com

Connect-Tek Inc.
www.connect-tek.com

Dawn VME Products
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Tracewell Systems
www.tracewellsystems.com

Vector Electronics & Technology Inc.
www.vectorelect.com

ELECTRO OPTICS watch

Barco to provide rugged displays for Predator UAV ground control stations

Unmanned aerial vehicle (UAV) designers at General Atomics Aeronautical Systems in San Diego needed rugged display technology for their legacy Predator UAV ground control station. They found their solution from Barco Federal Systems LLC in

Duluth, Ga. General Atomics awarded a follow-on order to Barco for the Barco TL-248 19-inch rugged LCD for Predator control stations. Barco has provided rugged displays to General Atomics for this program since 1989. The TL-248 rugged flat panel features a 19-inch active matrix liquid crystal display (AMLCD) in a rugged, yet thin and lightweight package. Barco's most rugged version is designed as a fully enclosed, drip-proof unit and includes a front-bonded optical stack and integrated heater to withstand sub-zero temperatures. Each predator ground control station employs four TL-248 displays in two top-down configurations, one each for the pilot and co-pilot. The pilot controls and monitors the UAV while the co-pilot views reconnaissance data gathered from the live video feeds captured by aircraft's nose-mounted camera.

FOR MORE INFORMATION visit **General Atomics Aeronautical Systems** online at www.ga-asi.com, or Barco Federal Systems at www.barco.com/federal.

Military laser systems from Northrop Grumman to protect Navy helicopters from shoulder-fired missiles

BY **John Keller**

PATUXENT RIVER NAS, Md.—The Northrop Grumman Corp. Electronic Systems segment in Rolling Meadows, Ill., will provide the U.S. Navy with military laser systems designed to protect heavy-lift helicopters from advanced shoulder-fired heat-seeking missiles under terms of a $77.7 million contract.

The Naval Air Systems Command at Patuxent River Naval Air Station, Md., is contracting with Northrop Grumman to provide 121 AN/AAQ-24(V) Guardian laser transmitter assemblies for Navy CH-53D, CH-53E, and CH-46E medium- and heavy-lift helicopters. These laser transmitters are part of the Northrop Grumman Large Aircraft Infrared Countermeasures (LAIRCM) directable laser-based countermeasures system for protecting helicopters and

The Northrop Grumman AN/AAQ-24(V) Guardian laser system, shown above, will help protect Navy CH-53D, CH-53E, and CH-46E medium- and heavy-lift helicopters from shoulder-fired missiles.

FLIR Systems acquires ICx to boost expertise in homeland security, surveillance, and chemical sensors

BY **John Keller**

WILSONVILLE, Ore.—Infrared sensor specialist FLIR Systems Inc. in Wilsonville, Ore., is acquiring homeland security sensors expert ICx Technologies Inc. in Arlington, Va., to boost FLIR's expertise in chemical, biological, radiological, nuclear, and explosive detection, as well as in wide-area surveillance, intrusion detection, and facility security.

FLIR is acquiring ICx for $274 million under terms of a merger agreement. For the year ended 30 June 2010, ICx reported revenue of about $168 million.

The acquisition expands FLIR's capabilities into advanced sensors for chemical, biological, radiological, nuclear, and explosives (CBNRE) detection for defense and homeland security markets. The acquisition also enhances FLIR's existing intelligence surveillance and reconnaissance product suite through the addition of ICx's advanced radars and integrated platforms. Upon closing of the transaction, ICx's operations will be integrated into FLIR's Government Systems Division. The transaction is expected to close this fall.

FOR MORE INFORMATION visit **FLIR Systems** online at www.flir.com, or **ICx Technologies** at www.icxt.com.

some fixed-wing aircraft from man-portable air defense systems (MANPADS). Northrop Grumman should be finished with this work in August 2012.

Most aircraft can protect themselves from typical heat-seeking missiles by deploying flares that confuse incoming missiles with many different false targets and cause the missiles to go off course. Modern shoulder-fired missiles such as the U.S.-made Stinger and Russian-made Igla, however, have sophisticated missile-guidance systems designed to defeat flare-based missile-defense systems.

Stinger and Igla have dual-mode seekers that blend infrared and ultraviolet sensors able to distinguish aircraft from flare countermeasures. To defeat these advanced anti-aircraft missiles, something more sophisticated is necessary, such as the Guardian directional infrared countermeasure (DIRCM) system, which uses ultraviolet sensors to detect incoming missiles, and a laser to defeat the missile's guidance system. Guardian directs a laser at the incoming missile's seeker to cause guidance errors and induce the missile to fly harmlessly off course.

Northrop Grumman won an $80 million Navy contract last month to deliver more than 450 infrared missile warning systems (IRMWS) and 90 infrared warning processors to protect Navy medium- and heavy-lift helicopters from ground-fired missiles. These IRMWS and processor systems work together with Guardian laser transmitters in LAIRCM systems on U.S. Marine Corps CH-53E, CH-46E, and CH-53D helicopters.

The Northrop Grumman LAIRCM system also forms the baseline for the company's Common Infrared Countermeasures offering for the upcoming U.S. Army competition to supply an advanced infrared countermeasures systems, company officials say.

FOR MORE INFORMATION
visit **Northrop Grumman Electronic** Systems online at *www.es.northropgrumman.com*, or **Naval Air Systems Command** at *www.navair.navy.mil.*

ELECTRO OPTICS watch

BAE Systems to provide thermal weapon sight for Army rifles, machine guns, and mounted weapons

BAE Systems is providing the U.S. Army with thermal weapon sights for rifles, machine guns, and mounted weapon systems.

BY **John Keller**

LEXINGTON, Mass.—U.S. Army officials needed thermal weapon sight technology for rifles, machine guns, and mounted weapon systems for infantry soldiers in combat. They found their solution from the BAE Systems Electronic Solutions segment in Lexington, Mass.

BAE Systems won a $123 million Army contract to continue production of thermal sights that improve situational awareness and survivability for infantry soldiers, company officials announced. The order increases the BAE Systems total thermal weapon sight contract value to more than $1 billion since 2004, company officials say.

BAE Systems Electronic Solutions produces light, medium, and heavy thermal weapon sights using the company's MicroIR uncooled infrared sensor technology to generate superior IR imagery without the need for bulky, power-consuming cryogenic cooling equipment.

In April, BAE Systems also received a $14 million contract to provide thermal weapon sights to the Canadian army. These weapon sights enable operators to see deep into the battlefield in darkness and through smoke, fog, and other obscurants, to help them detect and identify targets at long ranges.

The company tests its thermal sites for their ability to withstand harsh battlefield environments, and to date has delivered more than 80,000 sights to meet Army fielding requirements in Iraq and Afghanistan.

FOR MORE INFORMATION visit **BAE Systems Electronic Solutions** online at *www.baesystems.com.*

ELECTRO OPTICS watch

Electro-optical sensor system from FLIR Systems to help defend Navy ships from terrorist attacks

BY **John Keller**

CRANE, Ind.—U.S. Navy ship systems designers needed electro-optical sensor systems for the Shipboard Protection System (SPS), which helps protect Navy surface vessels from terrorist attacks while moored to piers, at anchor, or during restricted maneuvering. They found their solution from FLIR Systems in Wilsonville, Ore.

FLIR will provide the Navy with Star SAFIRE series electro-optical sensor (EOS) systems, containing forward-looking infrared (FLIR) sensor and laser detection and ranging tracking system under terms of a $27.1 million contract. Awarding the contract is the Naval Surface Warfare Center (NSWC) Crane Division in Crane, Ind.

The Navy Burke-class destroyer USS Oscar Austin, pictured above, uses electro-optical sensors from FLIR Systems to defend against terrorist attack.

These EOS systems are rugged and ship-mountable systems to provide surface ships with a day and night, high-resolution, infrared, and visible band imaging capability, as well as range finding capability, to augment existing optical and radar sensors for detecting and identifying potential terrorist or unconventional threats.

SPS is designed to increase the anti-terrorism/force protection (AT/FP) capabilities of naval vessels by providing 360-degree situational awareness and a flexible layered defense with engagement zones that are defined by the system operator. The SPS entered low-rate initial production last year, and is installed on the Navy's Burke-class destroyers USS Benfold (DDG 65), USS Donald Cook (DDG 75), USS Laboon (DDG 58), and USS Oscar Austin (DDG 79). The system will go aboard Ticonderoga-class cruisers, amphibious assault ships, and aircraft carriers beginning in 2012.

The FLIR Systems Star SAFIRE electro-optical sensor system is in use in the Royal Danish Navy on several ship classes, by the U.S. Navy for the SPS/EOS program, by the U.S. Coast Guard in the Deepwater program, and by other naval forces for surveillance and fire control. The Navy designed the SPS system in response to the devastating attack by terrorist suicide fast boats on the destroyer USS Cole (DDG 67) at the port of Aden in October 2000.

FOR MORE INFORMATION
visit **NSWC Crane** online at *www.navsea.navy.mil/nswc/crane*, or **FLIR Systems** at *www.flir.com*.

PRODUCT applications

UNMANNED AERIAL VEHICLES

AeroVironment to provide all-digital Puma UAV for surveillance and reconnaissance applications

AeroVironment Inc. (AV) won a contract delivery order worth $35.3 million for digital Puma All Environment (AE) unmanned aircraft systems (UAS), spares, and training services. The equipment and services were procured under the existing USSOCOM All Environment Capable Variant (AECV) contract.

Puma systems, which are capable of performing multiple surveillance and reconnaissance missions over water or land, will be used to protect troops and vehicles in combat areas.

Each Puma system consists of three air vehicles and two ground control systems. The air vehicle carries an integrated electro-optical and infrared gimbaled video camera, is designed for enhanced survivability in land and maritime environments, and can operate effectively in foul weather and over rugged terrain.

Its quiet operation, stabilized imagery, and precision landing capability make Puma systems easy to operate and recover, says a company spokesperson. The Puma air vehicle weighs 13 pounds, is battery powered, and has a flight endurance of two hours. Work is scheduled to be performed within a period of several months.

FOR MORE INFORMATION visit **AeroVironment** online at *www.avinc.com.*

GUIDANCE AND TELEMETRY

Harris Corp. to provide missile telemetry modules for Air Force AMRAAM

Harris Corp. in Melbourne, Fla., will provide telemetry modules that support the U.S. Air Force Advanced Medium-Range Air-to-Air Missile (AMRAAM) under terms of an $18 million, 2.5-year contract.

During test and training firings at Tyndall Air Force Base, Fla., the Harris Warhead Replacement Tactical Telemetry Module provided weapon system evaluators with critical flight and performance information about the AMRAAM.

The AIM-120 AMRAAM takes advantage of the target detection capabilities of the advanced radar systems of modern-day warplanes. This follow-on contract brings the overall value of the program for Harris to $154 million since 1991.

The module also has command destruct capability for the missile from the time it is launched from F-15, F-16, and F/A-22 aircraft until final impact.

"The proven performance, reliability, and availability of our telemetry modules are key contributors to the long-standing success of the Air Force's Weapon System Evaluation program," says Pat Seamon, vice president of avionics and electronics programs at Harris Government Communications Systems.

FOR MORE INFORMATION visit **Harris** online at *www.harris.com.*

POWER MANAGEMENT

Power-charging technology for experimental military micro-grids provided by Rapid Electric Vehicles

Rapid Electric Vehicles (REV) in Vancouver, British Columbia, won a contract for its bi-directional charging technology for micro-grids. Through a contract with Honeywell, REV will participate in the U.S. Army Tank Automotive Research Development Engineering Center (TARDEC) Micro-Grid project at Wheeler Air Base, Hawaii.

The project involves the design, building, and demonstration of a Micro-Grid with plug-in electric vehicles. It will help determine the technical readiness of Micro-Grids to accept power from various inputs while charging selected

vehicles and provide output power to various applications in both alternating and direct current systems.

"This is an important milestone for REV," says REV CEO Jay Giraud. "The U.S. Military is one of many federal partners we have been pursuing that manage the largest fleets in the world. With these vehicles in operation we can build case studies that demonstrate the viability and ROI for such game-changing technologies."

FOR MORE INFORMATION visit **Rapid Electric Vehicles** online at *www.rapidelectricvehicles.com.*

SATELLITE COMMUNICATIONS

L-3 GCS to provide satellite communications terminals to U.S. Special Operations Command

The **L-3 Communications GCS subsidiary (L-3 GCS)** in Victor, N.Y., will provide its Panther very small aperture terminal (VSAT) manpack satellite communications systems to the U.S. Special Operations Command (USSOCOM) at MacDill Air Force Base, Fla., to support USSOCOM's Special Operations Forces Deployable Node-Lite (SDN-Lite) program, which will provide worldwide satellite communications connectivity to Special Operations Forces field personnel. The contract is valued at up to $170 million over the next five years.

L-3 GCS will begin shipping MIL-tested and certified Ku-, Ka-, and X-band manpacks, data kits, and power systems to USSOCOM this calendar year, with additional units scheduled for production and delivery over the life of the contract.

"L-3 GCS is particularly honored to have been selected by USSOCOM for this important program to augment warfighter communications," says Bob Jacobson, president of L-3 GCS. "For the past two years, our goal has been to bring the size of a VSAT terminal down to a rucksack-sized package. We have achieved that goal, and USSOCOM has validated our vision with this award. Now, a single warfighter can have a megabit-per-second, beyond line-of-sight radio in his or her rucksack."

RADAR

ITT provides thin layered radar array for BAMS UAV for sense and avoid capability

Engineers at **ITT Electronic Systems** in Van Nuys, Calif., designed a thin-tile array radar system for sense and avoid capability in the U.S. Navy's Broad Area Maritime Surveillance (BAMS) unmanned

aerial vehicle (UAV), produced by Northrop Grumman Corp. The radar will be located in the nose of the UAV.

To get the proper range and aperture you need a certain size, but the UAVs are small so a thin tile array was created that is almost conformal in nature be able to fit it into the aircraft. The technology is also scalable so ITT sees it fitting in even smaller spaces, albeit with smaller range, he adds.

The ITT system is certified for the Federal Aviation Administration's (FAA's) DO-178B certification standard. Arnold says that currently the FAA does not have a set of standards for sense and avoid, but that they are working on it. The Navy is driving this particular program, he adds.

FOR MORE INFORMATION visit **ITT Electronic Systems** online at *www.es.itt.com.*

UAV PAYLOADS

Trident Systems to provide UAV payloads contract for persistent surveillance on small unmanned vehicles

Persistent surveillance experts at the **U.S. Naval Air Warfare Center Aircraft Division Lakehurst** at Lakehurst Naval Air Station, N.J., needed technology solutions for persistent intelligence, surveillance, and reconnaissance (ISR) on small unmanned aerial vehicles (UAVs). They found their needed solution at Trident Systems Inc. in Fairfax, Va.

The Naval Air Warfare Center awarded Trident Systems a $48.5 million contract for persistent ISR technology on small UAVs.

The Naval Air Warfare Center at Lakehurst also procures persistent surveillance payloads for tethered aerostats and other airborne platforms.

Trident Systems produces UAV payloads such as the UAV-Mounted Foliage-Penetrating Synthetic Aperture Radar (TUFSAR) for small UAVs with wingspans shorter than eight feet for use with forward-deployed military units. TUFSAR is designed to extend capabilities for applications such as mobile convoy protection and secure communications relay.

The TUFSAR system helps fill a technology gap in small UAV payloads that until recently has limited UAV reconnaissance capabilities primarily to image capture.

The TUFSAR is an all-weather, foliage penetrating radar system that can provide persistent surveillance in smoke, fog, and darkness, company officials say.

FOR MORE INFORMATION visit **Naval Air Warfare Center Aircraft Division Lakehurst** online at *www.navair.navy.mil/lakehurst,* or **Trident Systems** at *www.tridsys.com.*

NAVIGATION AND GUIDANCE

Inertial measurement units from Northrop Grumman to supply Eurofighter Typhoon Tranche 3A

Northrop Grumman Corp. won a contract from EADS Defence & Security, through its Military Air Systems business unit, to deliver 88 inertial measurement units (IMUs) for Tranche 3A of the Eurofighter Typhoon.

Northrop Grumman's IMUs, which provide motion data for the aircraft, will be built by the company's German navigation systems subsidiary, Northrop Grumman LITEF. The Northrop Grumman LITEF subsidiary also provided IMUs for Tranche 1 and Tranche 2 of the aircraft.

Developed as part of the flight control system of the Eurofighter Typhoon, the IMU system, with its accurate inertial sensors and built-in redundancy, is the sole sensor which measures the motion of the aircraft and continuously provides motion data to the flight control computer to drive the control systems and actuators.

This closed control loop stabilization system enables the aircraft to perform with extreme agility as well as a high degree of maneuverability, ensuring it can operate to the maximum of its capability and to the limit of its flight envelope, Northrop Grumman officials say.

In a secondary function, the IMU provides backup navigation data.

More than 400 Northrop Grumman LITEF IMUs have been delivered. The devices are already in service on the Eurofighter in Germany, Spain, Italy, England, Austria, and Saudi Arabia.

FOR MORE INFORMATION visit **Northrop Grumman Corp.** online at *www.northropgrumman.com.*

new PRODUCTS

To submit new products for consideration, contact John Keller at jkeller@pennwell.com

RF AND MICROWAVE

Programmable frequency divider RF and microwave components introduced by Hittite

Hittite Microwave Corp. in Chelmsford, Mass., is introducing two ultra-low-noise programmable frequency divider RF and microwave components for signal generation in military communications applications that operate from 100 MHz to 15 GHz, as well as in test and measurement equipment and laboratory systems. The HMC862LP3E and HMC905LP3E are SiGe BiCMOS low-noise programmable frequency dividers in SMT packages. The HMC862LP3E can be programmed to divide from N = 1, 2, 4, 8 in the 100 MHz to 15 GHz input frequency range. The HMC905LP3E can be programmed to divide from N = 1, 2, 3, 4 in the 400 MHz to 6 GHz frequency range. The HMC862LP3E has low phase noise of -153 dBc/Hz at offset frequencies greater than 100 kHz, wide frequency range, and flexible division ratio for wideband communications systems. The HMC905LP3E has high level output power of as much as 6 dBm single ended, with a low SSB phase noise of -158 dBc/Hz at offset frequencies greater than 100 kHz, and 50 percent duty cycle for low-noise clock generation, LO generation, and LO drive applications.

FOR MORE INFORMATION visit **Hittite** online at *www.hittite.com.*

POWER ELECTRONICS

3U CompactPCI power supply for military and avionics applications introduced by X-ES

Embedded computing expert Extreme Engineering Solutions (X-ES) in Middleton, Wis., is introducing the XPm2010 3U PICMG 2.11 cPCI power supply that takes in MIL-STD-704 28-volt DC input voltage and provides as much as 300 watts of power on 3.3, 5, and 12 volts at 90 percent efficiency for U.S. and international military and avionics applications in 3U CompactPCI air transport rack (ATR) systems.

The XPm2010 operates from 16 to 50 volts steady state while maintaining as much as 300 watts of isolated output power. It provides as much as 25 amps on 3.3 volts, 22 amps on 5 volts, and 8.3 amps on 12 volts in a 3U cPCI form factor. Integrated MIL-STD-461E electromagnetic interference (EMI) filtering is provided, and with an optional hold-up capacitor the XPm2010 provides as much as 60 milliseconds of hold up time at 120 watts.

FOR MORE INFORMATION visit **X-ES** online at *www.xes-inc.com.*

EMBEDDED COMPUTING

OpenVPX Intel Core i7-based single-board computer with POET switch fabric bridge introduced by Mercury

Mercury Computer Systems Inc. in Chelmsford, Mass., is introducing the Ensemble 6000 Series 6U OpenVPX Intel Core i7-based LDS6520 single-board computer for intelligence, surveillance, and reconnaissance (ISR) applications. The embedded computing product combines the Intel Core i7 processor with the Mercury Protocol Offload Engine Technology (POET) switch fabric interconnect bridge. ISR subsystems using several Mercury LDS6520 modules benefit from fast and low latency data communications between Intel Core i7 devices, Mercury officials say. The POET-equipped LDS6520 enables a serial RapidIO or low-latency, 10-Gigabit Ethernet data plane to connect several Intel Core i7 processors and field-programmable gate arrays (FPGAs) for high-speed data connections and system scaling for Intel devices in defense applications.

FOR MORE INFORMATION visit **Mercury Computer Systems** online at *www.mc.com.*

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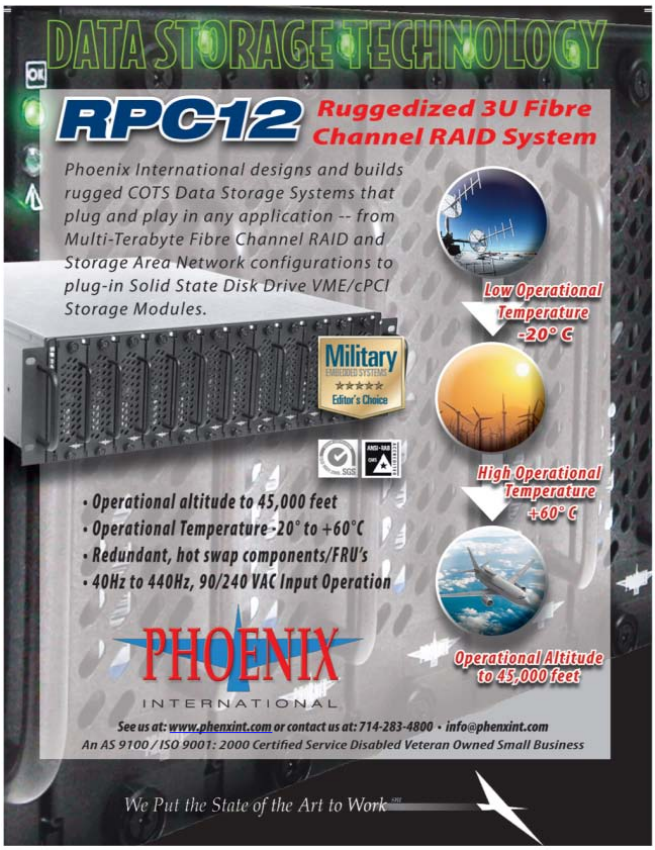

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Avionics Intelligence

DARPA Vulture program to use SolarEagle UAV from Boeing

Boeing signed an agreement with the U.S. Defense Advanced Research Projects Agency (DARPA) to develop and fly the SolarEagle unmanned aerial vehicle (UAV) for the Vulture II demonstration program. Under the terms of the $89 million contract, SolarEagle will make its first demonstration flight in 2014.

"SolarEagle is a uniquely configured, large unmanned aircraft designed to eventually remain on station at stratospheric altitudes for at least five years," says Pat O'Neil, Boeing Phantom Works program manager for Vulture II. "That's a daunting task, but Boeing has a highly reliable solar-electric design that will meet the challenge in order to perform persistent communications, intelligence, surveillance, and reconnaissance missions from altitudes above 60,000 feet." *www.avionics-intelligence.com*

Defense Executive

Navy surveys industry for expertise in unmanned vehicle common control station technology

Researchers at the U.S. Naval Air Systems Command (NavAir) at Patuxent River Naval Air Station, Md., are surveying industry for companies able to design and build a common control station for all unmanned vehicles operating on the ground, at sea, and in the air. This common control system (CCS) should be able to perform vehicle command and control, payload command and control, mission planning, and data dissemination across all domains—land, sea, undersea, and air.

NavAir officials released a request for information in late September (RFI N00019-10-P7-ZD307) for the Common Control System (CCS) for Unmanned Systems Capabilities program to learn more about industry research, technologies, and existing programs that could support several different unmanned systems. *http://bit.ly/caFBWV*

Mil-aero blog

Executive layoffs signal tough times ahead

Boeing and Lockheed Martin leaders call it re-aligning, focusing on core competencies, better positioning for the future, empowering the younger generation, yadda, yadda, yadda... but what they really mean is that the Obama Administration's next Department of Defense budget is likely to be a lot smaller than in years past and the big primes want to hoard their cash now by eliminating high-level executive salaries—about 600 in the case of Lockheed Martin. These recent announcements from behemoths—Lockheed Martin and Boeing—are probably only the beginning. *http://bit.ly/cbBbwq*

Command Post Community

You need a custom BIOS when...

Many times a minor tweak to the BIOS of a single-board computer or embedded motherboard can greatly enhance the industrial computer system user experience. The BIOS customization can be relatively simple such as adding a customer's company logo to the system start-up screen or as complex as re-ordering a system's boot priority to match a customer's system start-up requirements. Either way, you want to ensure that the system integrator you work with understands both your system sub-component configuration needs as well as how the BIOS of the SBC or motherboard can be optimized. *http://community.milaero.com*

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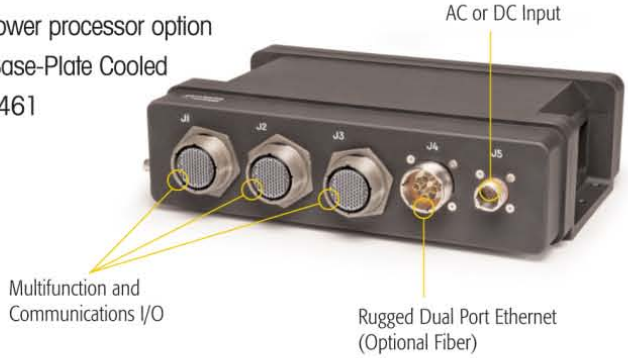

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